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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION, APRIL 2018

Course Code: CH312

Course Name: CHEMICAL ENGINEERING DESIGN - I

Max. Marks: 100 Duration: 3 Hours

Marks

Judicious assumptions may be used wherever necessary.

The following are permitted in the examination hall:

1. ***Steam tables and Psychrometric Charts***
2. ***Perry's Hand Book of Chemical Engineering***
3. ***The certified copies or originals of the codes IS 2825:1969; IS 803:1976; IS1730:1989; IS 4503:1969.***
4. ***Certified copies of the handouts of complex equations, tables and graphs required for the design***

PART A

Answer any 2 full questions, each carries 50 marks.

1 a) A horizontal 1-4 condenser is required for condensation of 25000 kg/hr of pure ammonia coming from a reactor operating at 1.05 kg/cm^2 gauge, at which pressure it boils at 200°C. Water at 30°C will be used as the cooling medium. A dirt factor of 0.0003 hr ft^2 ^{o}F/BTU is required with allowable pressure drop of 0.14 kgf/cm^2 for vapour and 0.7 kgf/cm^2 for water. Assume 8 ft tube length with ¾ inch OD, 16 BWG on 15/16 inch pitch. Water flow rate is 2,00,000 kg/h. (50)

i) Design a suitable condenser for the given process. (35)

ii) Calculate pressure drop. (5)

iii) Provide a representative sketch of the condenser. (10)

2 a) Bottom residue of a distillation column unit T102 is send to a Reboiler HE117 and returned to the column. LP steam is the heating medium. Develop a suitable P&ID of the Reboiler showing control of residue temperature. (25)

b) A storage tank with 20 m in diameter and 12 m in height is to be designed for (25)

oil having a density of 940 kg/m^3. Permissible stress of material is 11.8 kg/mm^2. Corrosion allowance is 1.5 mm. Welded joint efficiency is 70%. Estimate the number of courses and thickness of shell.

3 a) A tall vertical column 2.5m in outer diameter and 40m in height is to be designed. The available specifications are: (25)

Operating temperature and pressure - 160°C and 4 kg/cm^2(g)

Skirt height – 3m

Tray spacing – 0.6m

Top disengagement space – 1.2mm

Weir Height – 60mm

Bottom separation space -1.8m

Tray loading with liquid – 110 kg/m^2

Tray support ring – 45mm x 45mm x 11mm angles

Corrosion allowance – 2 mm

Wind force acting – 110 kg/m^2

Design pressure – 4.8 kg/cm^2

Insulation thickness – 115mm

Permissible material stress of shell – 780 kg/ m^2

Welded joint efficiency – 0.85

Density of shell material – 7700 kg/m^3

Density of insulation – 480 kg/m^3

Over head vapor pressure line – 280 mm

Weight of ladder – 30 kg/m

Weight of 280 mm outer diameter pipe – 55 kg/m

b) A straight type skirt support welded in line with the shell of a column has to be designed based on the following data: (25)

Outer diameter of column = 2500mm; Height of vessel = 26m; Weight of column and attachments = 1.6 x 10^5 kg; Height of skirt = 4m; Seismic coefficient = 0.1; Wind pressure = 13kgf/m^2; Bearing capacity of concrete = 0.35 kg/mm^2; Permissible bending stress for steel = 165kg/mm^2. Estimate the standard plate thickness for skirt and bearing plate and number of bolts/anchor bolts required.

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